CLAIMS

What is claimed is:

1. An electrophotographic image forming apparatus comprising:

a photosensitive medium;

a charging unit to charge a surface of the photosensitive medium to a uniform potential;

an exposure unit to scan light over the surface of the photosensitive medium to form an electrostatic latent image on the surface of the photosensitive medium;

a developing roller to develop the electrostatic latent image by applying a developer to the electrostatic latent image;

a developer supplying roller to supply the developer to the developing roller;

a transfer unit to transfer the developed image on the surface of the photosensitive medium to a sheet of print paper;

a current measuring unit to measure a developing current flowing between the developing roller and the photosensitive medium; and

a controlling unit to calculate a value representing at least one of a thickness of a photosensitive film of the photosensitive medium, a thickness of the developer on a surface of the developing roller, and a quantity of development on the surface of the photosensitive medium using the measured developing current, and to display information concerning replacement of a consumable or to control development parameters according to the calculated value.

2. The electrophotographic image forming apparatus according to claim 1, wherein the current measuring unit is a current measuring circuit provided between the developing roller and a developing power source applying a developing potential to the developing roller.

3. The electrophotographic image forming apparatus according to claim 1, wherein the current measuring unit measures values representing first, second and third developing currents in three modes, respectively, and the three measured values of the first, second, and third developing currents are used in the controlling unit to calculate the thickness of the photosensitive film of the photosensitive medium, the thickness of the developer on the surface of the developing roller, and the quantity of development on the surface of the photosensitive medium.

4. The electrophotographic image forming apparatus according to claim 3, wherein the three modes comprise:

a first mode in which the first developing current is measured in a state in which the photosensitive medium is charged to a charged potential, and a developing potential is applied to the developing roller;

a second mode in which the second developing current is measured in a state in which a developer supplying potential is applied to the developer supplying roller, and the developer is supplied to the surface of the developing roller in addition to the state of the first mode; and

a third mode in which the third developing current is measured in a state in which an electrostatic latent image is formed on the photosensitive medium, and the developer is attached to the electrostatic latent image in addition to the state of the second mode.

5. The electrophotographic image forming apparatus according to claim 1, wherein the controlling unit comprises:

a CPU which calculates desired values using the measured developing current, determine whether the consumable must be replaced by comparing the calculated values with preset standard values, and controls the development parameters;

a memory portion to store a lookup table having the standard values to be referenced by the CPU; and

a display portion to display information concerning replacement of the consumable according to determination of the CPU concerning whether the consumable must be replaced.

6. The electrophotographic image forming apparatus according to claim 1, wherein the information concerning replacement of the consumable includes information concerning replacement of the photosensitive medium and information concerning replacement of the developer.

7. The electrophotographic image forming apparatus according to claim 1, wherein the development parameters includes a developer supply vector and a development vector.

8. A method of controlling development in an electrophotographic image forming apparatus comprising:

measuring a developing current flowing between a photosensitive medium and a developing roller in a state in which a surface of the photosensitive medium is charged to a charged potential, and a developing potential is applied to the developing roller;

calculating a capacitance of the photosensitive medium using the measured developing current, the charged potential, and the developing potential;

calculating a thickness of a photosensitive film of the photosensitive medium using the capacitance;

comparing the thickness of the photosensitive film with a preset allowable minimum thickness; and

displaying information concerning replacement of the photosensitive medium with a new one when the thickness of the photosensitive film is less than the allowable minimum thickness.

9. A method of controlling development in an electrophotographic image forming apparatus comprising:

measuring a developing current flowing between a photosensitive medium and a developing roller in a state in which a surface of the photosensitive medium is charged to a charged potential, and a developing potential and a developer supplying potential are applied to the developing roller and a developer supplying roller, respectively, so that a developer can be supplied to a surface of the developing roller;

calculating a potential of the developer on the surface of the developing roller using the measured developing current, the charged potential, the developing potential, and a capacitance of the photosensitive medium;

calculating a thickness of the developer on the surface of the developing roller using the potential of the developer;

comparing the thickness of the developer with a preset allowable minimum thickness; and

displaying information concerning replacement of the developer when the thickness of the developer is thinner than a preset allowable minimum thickness.

10. The method of controlling development in an electrophotographic image forming apparatus according to claim 9, wherein after the displaying operation, the method further comprises:

determining whether the thickness of the developer is within a preset standard thickness range when the thickness of the developer is the same as or greater than the allowable minimum thickness; and

controlling a developer supply vector so that the thickness of the developer can be within the standard thickness range when the thickness of the developer is out of the standard thickness range.

11. The method of controlling development in an electrophotographic image forming apparatus according to claim 10, wherein in the controlling operation of the developer supply vector, the developer supply vector is controlled by controlling the developer supplying potential.

12. The method of controlling development in an electrophotographic image forming apparatus according to claim 10, wherein in the controlling operation of the developer supply vector, the developer supply vector is controlled using data concerning variations in the thickness of the developer with respect to increase and decrease of the developer supply vector, and the data are stored in advance in a lookup table.

13. The method of controlling development in an electrophotographic image forming apparatus according to claim 9, wherein in the calculating operation of the thickness the developer, the thickness of the developer is calculated by a proportional expression concerning a relationship between the potential of the developer and the thickness of the developer.

14. The method of controlling development in an electrophotographic image forming apparatus according to claim 9, wherein in the calculating operation of the thickness of the developer, the thickness of the developer is calculated by comparing the potential of the developer calculated in the calculating operation of the potential of the developer with data concerning variations in the thickness of the developer with respect to increase and decrease of a developer supply vector, wherein the data are stored in advance in a lookup table.

15. A method of controlling development in an electrophotographic image forming apparatus comprising:

measuring a developing current flowing between a photosensitive medium and a developing roller in a state in which an electrostatic latent image is formed on a surface of the photosensitive medium, a developing potential and a developer supplying potential are applied

to the developing roller and a developer supplying roller, respectively, and a developer is supplied to a surface of the developing roller so that the developer can be attached to the electrostatic latent image;

calculating an exposure potential of the electrostatic latent image using the measured developing current, the developing potential, the potential of the developer, and a capacitance of the photosensitive medium;

calculating a quantity of development on the surface of the photosensitive medium using the exposure potential;

determining whether the quantity of development is within a preset standard range; and

controlling a development vector so that the quantity of development can be within the standard range when the quantity of development is out of the standard range.

16. The method of controlling development in an electrophotographic image forming apparatus according to claim 15, wherein after the calculating operation of the exposure potential of the electrostatic latent image, the method further comprises:

comparing the exposure potential with a preset allowable maximum potential; and

displaying information concerning replacement of the photosensitive medium when the exposure potential is greater than the allowable maximum potential.

17. The method of controlling development in an electrophotographic image forming apparatus according to claim 15, wherein in the calculating operation of the quantity of development, the quantity of development is calculated using a proportional expression concerning the relation between a development vector and the quantity of development with the exposure potential.

18. The method of controlling development in an electrophotographic image forming apparatus according to claim 15, wherein in the calculating operation of the quantity of development, the quantity of development is calculated by comparing the exposure potential calculated in the calculating operation of the exposure potential with data concerning variations in the quantity of development with respect to increase and decrease of the exposure potential, and the data is stored in advance in a lookup table.

19. The method of controlling development in an electrophotographic image forming apparatus according to claim 15, wherein in the controlling operation of the development vector, the development vector is controlled by controlling the developing potential.

20. The method of controlling development in an electrophotographic image forming apparatus according to claim 15, wherein in the controlling operation of the development vector, the development vector is controlled by using data concerning variations in the quantity of development with respect to increase and decrease of the development vector, and the data is stored in advance in a lookup table.

21. A method of controlling development in an electrophotographic image forming apparatus comprising:

measuring developing currents flowing between a photosensitive medium and a developing roller in three modes, respectively;

calculating a capacitance of the photosensitive medium, a potential of developer on a surface of the developing roller, and an exposure potential of an electrostatic latent image using the measured developing currents;

calculating a thickness of a photosensitive film of the photosensitive medium, a thickness of the developer on a surface of the developing roller, and a quantity of development on the photosensitive medium using values calculated in the calculating operation;

comparing the thickness of the photosensitive film with a preset allowable minimum thickness of the photosensitive film, and comparing the thickness of the developer with a preset allowable minimum thickness of the developer;

displaying information concerning replacement of the photosensitive medium when the thickness of the photosensitive film is less than the allowable minimum thickness of the photosensitive film, and displaying information concerning replacement of the developer when the thickness of the developer is less than the allowable minimum thickness of the developer;

determining whether the quantity of development is within a preset standard range; and

controlling a development vector so that the quantity of development can be within the standard range when the quantity of development is out of the standard range.

22. The method of controlling development in an electrophotographic image forming apparatus according to claim 21, wherein in the measuring operation, the three modes comprises:

a first mode in which the surface of the photosensitive medium is charged to a charged potential, and a developing potential is applied to the developing roller;

a second mode in which a developer supplying potential is applied to a developer supplying roller so that the developer can be applied to the surface of the developing roller in addition to the state of the first mode; and

a third mode in which an electrostatic latent image is formed on the surface of the photosensitive medium so that the developer can be attached to the electrostatic latent image in addition to the state of the second mode.

23. The method of controlling development in an electrophotographic image forming apparatus according to claim 22, wherein the calculating operation of the capacitance of the photosensitive medium comprises calculating the capacitance of the photosensitive medium using a first developing current measured in the first mode, calculating the potential of the developer on the surface of the developing roller using a second developing current measured in the second mode, and the calculated capacitance, and calculating the exposure potential of the electrostatic latent image formed on the surface of the photosensitive medium using a third developing current measured in the third mode, the calculated capacitance, and the calculated potential of the developer.

24. The method of controlling development in an electrophotographic image forming apparatus according to claim 21, wherein in the calculating operation of the thickness of the photosensitive drum, the thickness of the photosensitive film is calculated using the capacitance of the photosensitive medium, the thickness of the developer on the surface of the developing roller using the potential of the developer, and the quantity of development is calculated using the exposure potential.

25. The method of controlling development in an electrophotographic image forming apparatus according to claim 21, wherein in the controlling operation of the development vector, the development vector is controlled by controlling the developing potential.

26. The method of controlling development in an electrophotographic image forming apparatus according to claim 21, wherein after the calculating operation of the capacitance of the photosensitive medium, the method further comprises:

comparing the exposure potential with a preset allowable maximum potential; and

displaying information concerning replacement of the photosensitive medium when the exposure potential is greater than the allowable maximum potential.

27. The method of controlling development in an electrophotographic image forming apparatus according to claim 21, wherein after the displaying operation of the information, the method further comprises:

determining whether the thickness of the developer is within a preset standard thickness range when the thickness of the developer is the same as or greater than the allowable minimum thickness; and

controlling a developer supply vector so that the thickness of the developer can be within the standard thickness range when the thickness of the developer is out of the standard thickness range.

28. The method of controlling development in an electrophotographic image forming apparatus according to claim 27, wherein the developer supply vector is controlled by controlling the developer supplying potential.

29. A method of controlling development in an electrophotographic image forming apparatus, the method comprising:

measuring a developing current flowing between a developing roller and a photosensitive medium;

calculating a value representing at least one of a thickness of a photosensitive film of the photosensitive medium, a thickness of a developer on a surface of the developing roller, and a quantity of development on the surface of the photosensitive medium using the measured developing current; and

generating information concerning replacement of at least one of the photosensitive medium, the developing roller, and the developer, according to the calculated value.

30. The method of controlling development in the electrophotographic image forming apparatus according to claim 29, further comprising:

controlling development parameters according to the calculated value to control development on the photosensitive medium.

31. The method of controlling development in the electrophotographic image forming apparatus according to claim 29, wherein the calculating operation comprises:

calculating a capacitance of the photosensitive medium using the measured developing current, a potential of a developer using the measured developing current and the capacitance of the photosensitive medium, and an exposure potential of an electrostatic latent image formed on a surface of the photosensitive medium using the measured developing current and the potential of the developer and the capacitance of the photosensitive medium.

32. The method of controlling development in the electrophotographic image forming apparatus according to claim 31, wherein the calculating operation comprises:

calculating the thickness of the photosensitive film of the photosensitive medium using the capacitance of the photosensitive medium, the thickness of the developer attached to the surface of the photosensitive medium using the potential of the developer, and the quantity of the development using the exposure potential of the photosensitive medium.

33. The method of controlling development in the electrophotographic image forming apparatus according to claim 32, wherein the generating operation comprises:

comparing the thickness of the photosensitive film of the photosensitive medium with a first reference value, the thickness of the developer attached to the surface of the photosensitive medium with a second reference value, and the quantity of the development with a third reference value to generate a signal representing the information.

34. An electrophotographic image forming apparatus comprising:

a photosensitive medium;

a charging unit to charge a surface of the photosensitive medium to a uniform potential;

an exposure unit to scan light over the surface of the photosensitive medium to form an electrostatic latent image on the surface of the photosensitive medium;

a developing roller to develop the electrostatic latent image by applying a developer to the electrostatic latent image;

a developer supplying roller to supply the developer to the developing roller;

a transfer unit to transfer the developed image on the surface of the photosensitive medium to a sheet of print paper;

a current measuring unit to measure a developing current flowing between the developing roller and the photosensitive medium; and

a controlling unit to calculate a value representing at least one of a thickness of a photosensitive film of the photosensitive medium in a first mode, a thickness of the developer on a surface of the developing roller in a second mode, and a quantity of development on the surface of the photosensitive medium using the measured developing current in a third mode, and to display information concerning replacement of a consumable or controlling development parameters according to the calculated value,

wherein the control unit calculates a capacitance of the photosensitive medium using the measured developing current in the first mode, a potential of a developer using the measured developing current and the capacitance of the photosensitive medium in the second mode, and an exposure potential of an electrostatic latent image formed on a surface of the photosensitive medium using the measured developing current and the potential of the developer and the capacitance of the photosensitive medium in the third mode, calculates the thickness of the photosensitive film of the photosensitive medium using the capacitance of the photosensitive medium in the first mode, the thickness of the developer attached to the surface of the photosensitive medium using the potential of the developer in the second mode, and the quantity of the development using the exposure potential of the photosensitive medium in the third mode, and compares the thickness of the photosensitive film of the photosensitive medium with a first reference value in the first mode, the thickness of the developer attached to the surface of the photosensitive medium with a second reference value in the second mode, and the quantity of the development with a third reference value in the third mode to generate a signal representing the information.

35. A method of controlling development in an electrophotographic image forming apparatus, the method comprising:

measuring a developing current flowing between a developing roller and a photosensitive medium;

calculating a capacitance of the photosensitive medium using the measured developing current in a first mode, a potential of a developer using the measured developing current and the capacitance of the photosensitive medium in a second mode, and an exposure potential of an electrostatic latent image formed on a surface of the photosensitive medium using the measured developing current and the potential of the developer and the capacitance of the photosensitive medium in a third mode;

calculating a value representing at least one of a thickness of the photosensitive film of the photosensitive medium using the capacitance of the photosensitive medium in the first

mode, a thickness of the developer attached to the surface of the photosensitive medium using the potential of the developer in the second mode, and a quantity of the development using the exposure potential of the photosensitive medium in the third mode; and

comparing the thickness of the photosensitive film of the photosensitive medium with a first reference value in the first mode, the thickness of the developer attached to the surface of the photosensitive medium with a second reference value in the second mode, and the quantity of the development with a third reference value in the third mode, to generate a signal representing the information concerning replacement of a consumable or controlling development parameters, according to the calculated value.